

Jet Substructure Analysis

MPI Higgs Physics Analyses

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Cuts

- C0: All Events (CxAOD)
- C1: Pass trigger & trigger matching
- C2: Lepton preselection (1 VHLooseLepton, 1 WHSignalLepton)
- C3: MET > 30 GeV
- C4: $m_T(W) > 20$ GeV
- C5: $p_T(W) > 120$ GeV
- C6: ≥ 2 jets (signal & forward)
- C7: ≥ 2 signal jets
- C8: $|\min \Delta\phi(\text{MET}, \text{jet1}, \text{jet2}, \text{jet3})| > 1$
- C9: ≥ 1 b-tagged jet
- C10: = 2 b-tagged jets
- C11: $p_T(\text{leading jet}) > 45$ GeV
- C12: $95 < m(\text{bb}) < 140$ GeV after OneMuon correction

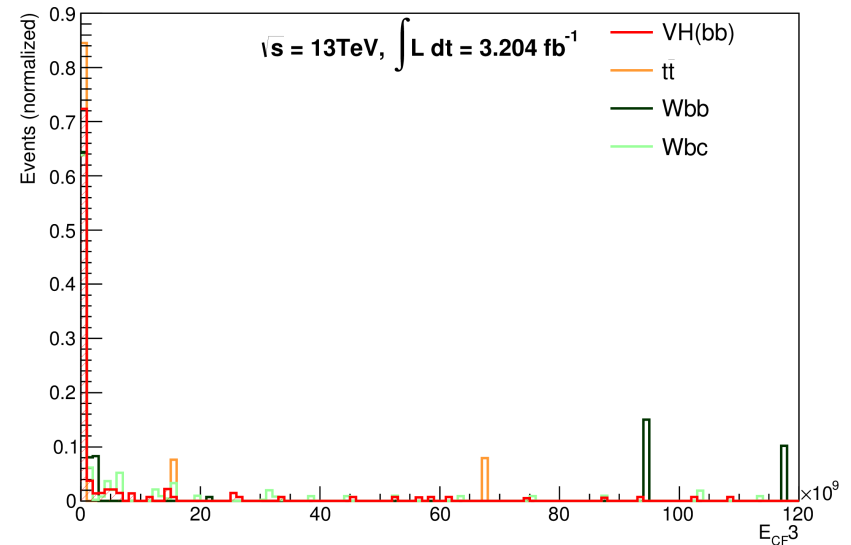
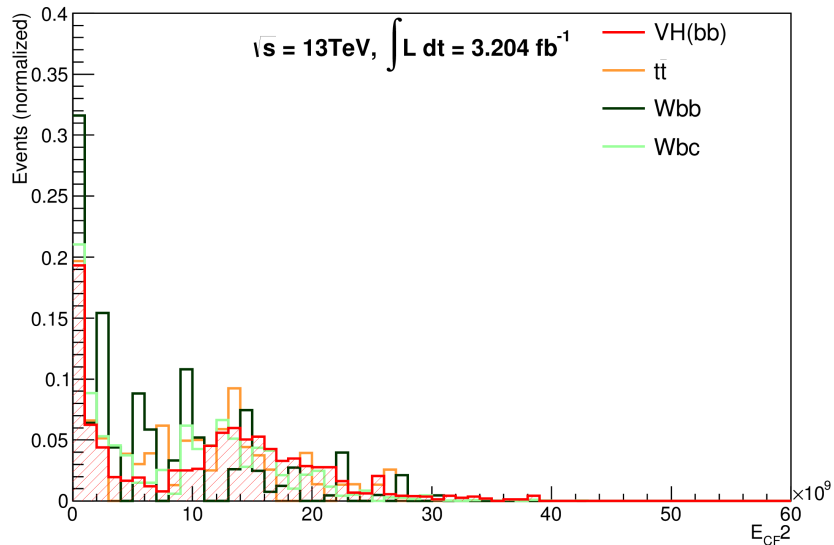
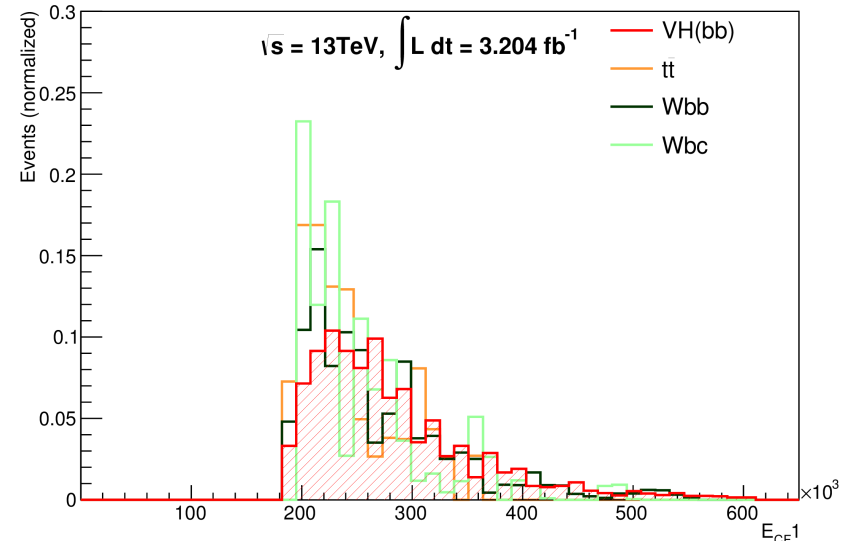
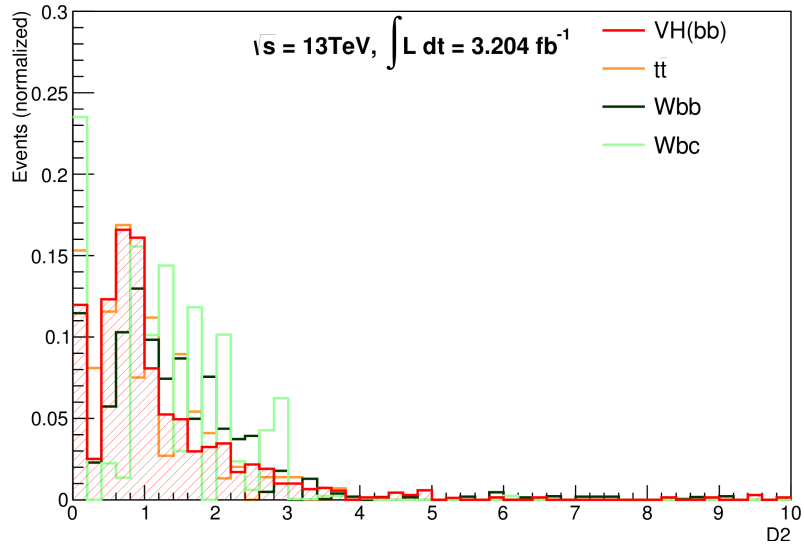
CxAODs from: /ptmp/mpp/fmueller/data/CxAOD_13TeV/CxAOD_00-18-00/HIGG5D2jss

Substructure variables

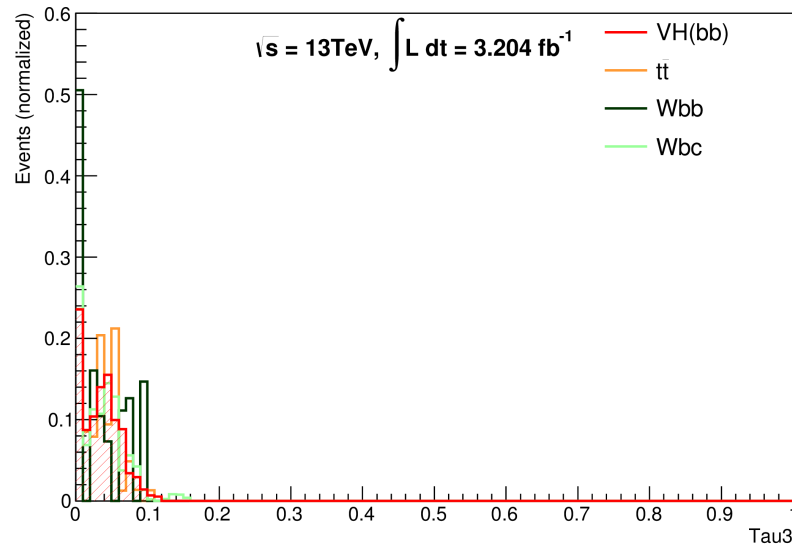
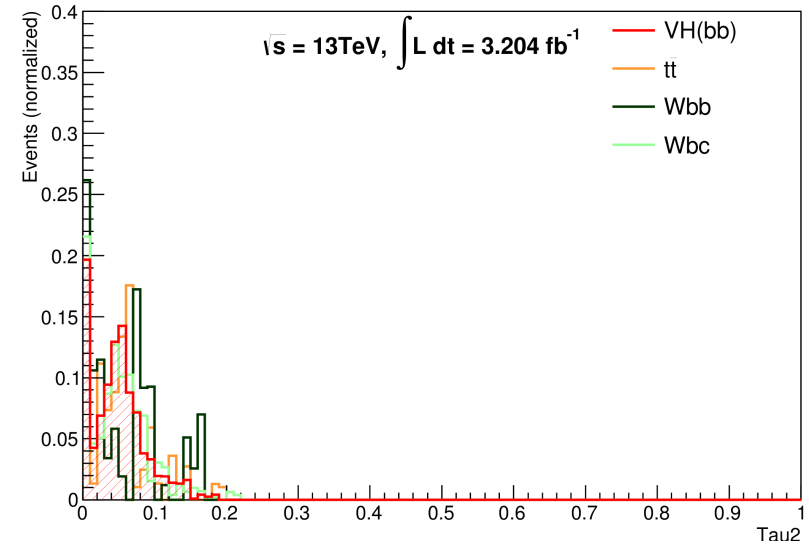
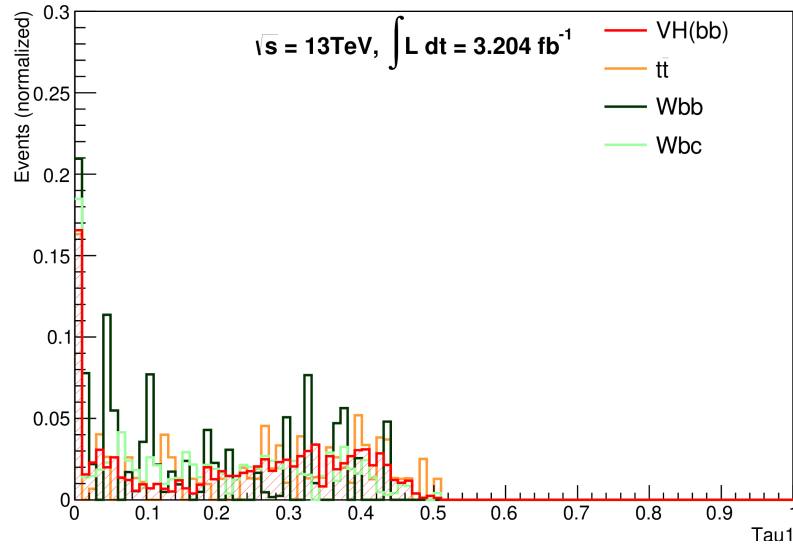
- N-subjettiness: Tau1, Tau2, Tau3, Tau1_wta, Tau2_wta, Tau3, Tau3_wta
- N-subjettiness ratios: Tau21, Tau32, Tau21_wta, Tau32_wta
- kT splitting scale: Split12, Split23, Split34
- Z-Cut: ZCut12, ZCut23, ZCut34
- Dipolarity: Dip12, Dip13, Dip23, DipExcl12
- Angularity, Sphericity, Apolarity
- kT Delta R: KtDR
- kT Mass drop: Mu12
- PlanarFlow
- Energy correlations: ECF1, ECF2, ECF3
- ECF ratios: C2, D2
- Thrust: ThrustMin, ThrustMaj
- FoxWolfram: FoxWolfram0, FoxWolfram1, FoxWolfram2, FoxWolfram3, FoxWolfram4

[<https://twiki.cern.ch/twiki/bin/view/AtlasProtected/JetSubstructureTools>]

Plots D2, ECF1, ECF2, ECF3



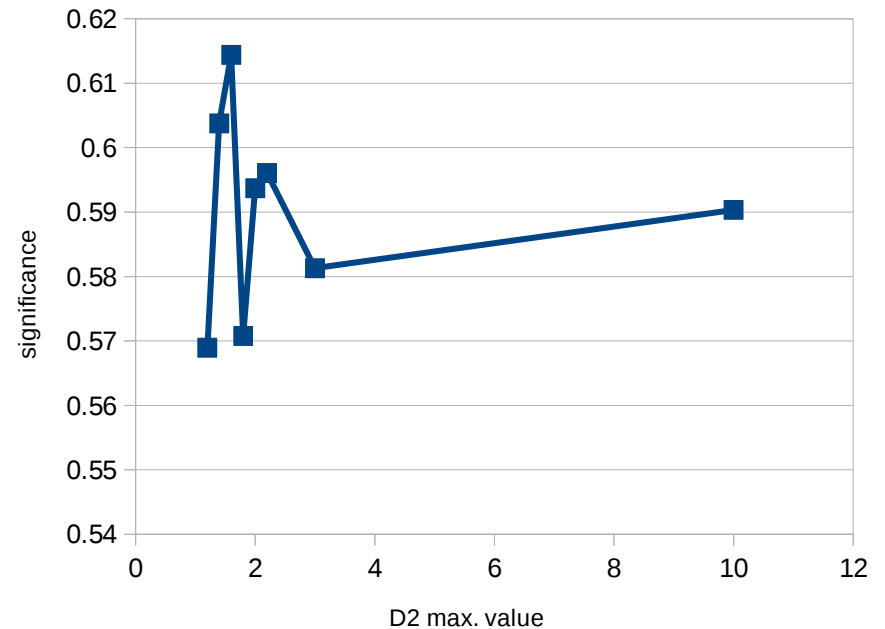
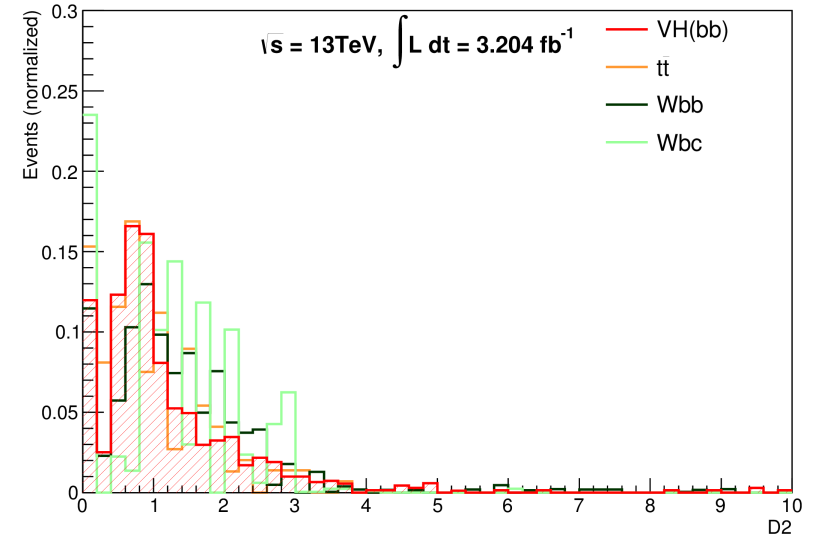
Plots Tau1, Tau2, Tau3



D2 substructure variable

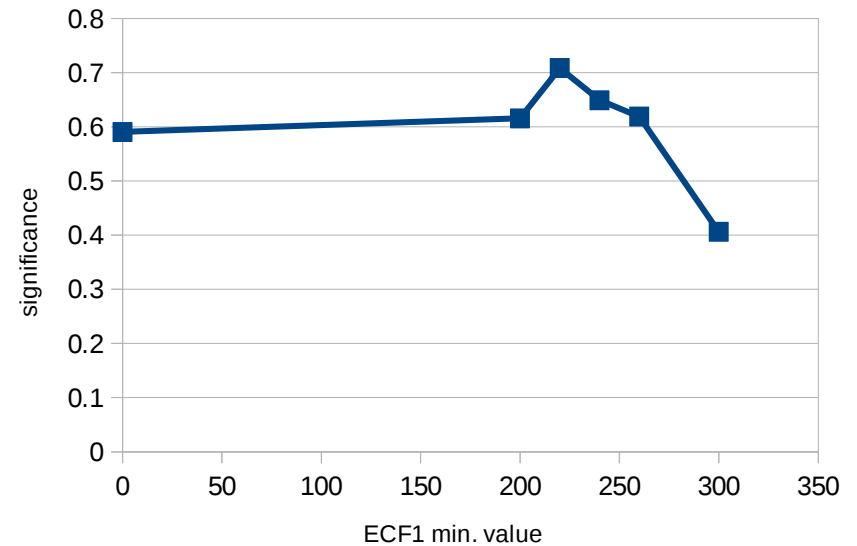
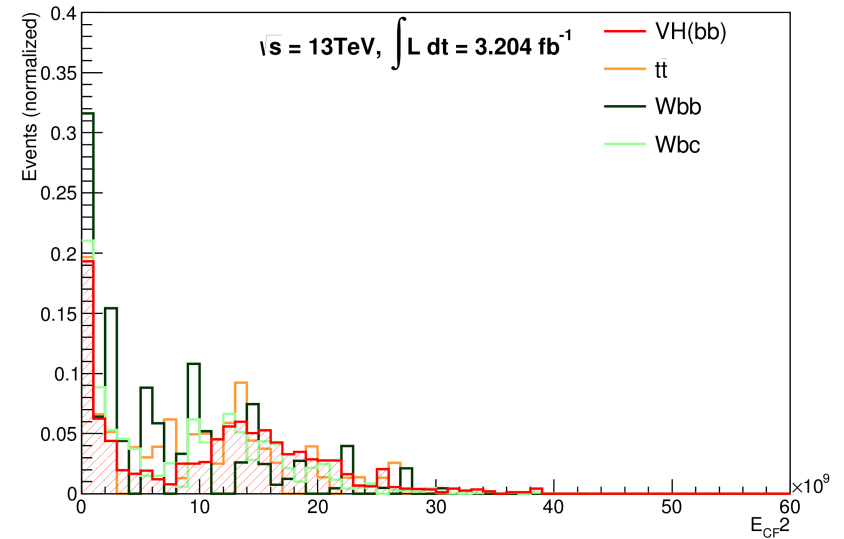
D2	WH	Bkg.*	Signific.
all	2.2973	14.3973	0.5903
<1.2	1.6516	7.8944	0.5689
<1.4	1.8715	9.0038	0.6038
<1.6	1.9068	9.0172	0.6144
<1.8	1.9219	10.7149	0.5708
<2.0	2.0090	10.7991	0.5937
<2.2	2.0614	11.2925	0.5961
<3.0	2.2010	13.6216	0.5813
0.2-1.6	1.5923	5.3489	0.6580
0.4-1.6	1.5448	5.3340	0.6400

* Bkg. = $t\bar{t}$ + Wbb + Wbc + Wbl + Wcc + Wcl + $stop_t$ + $stop_Wt$



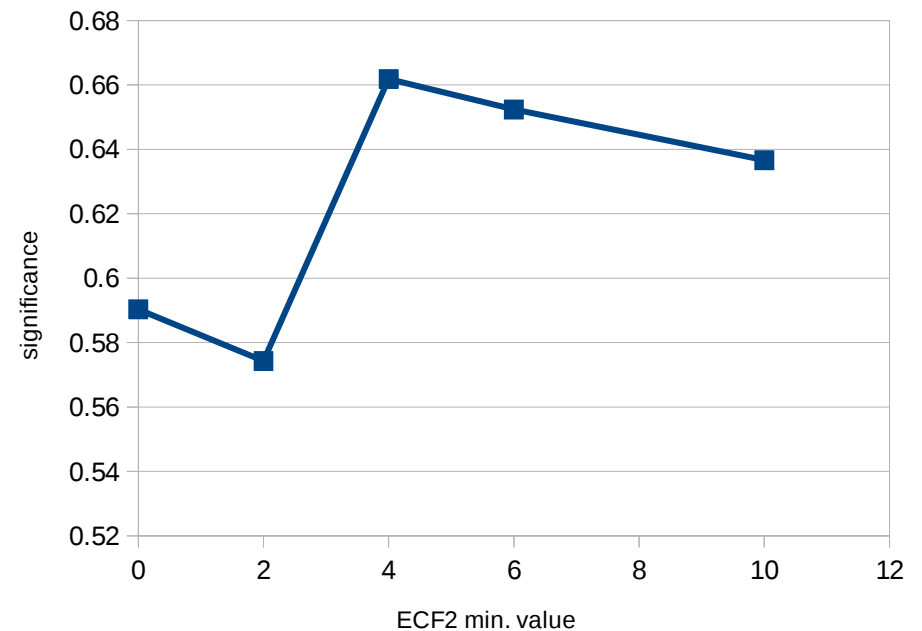
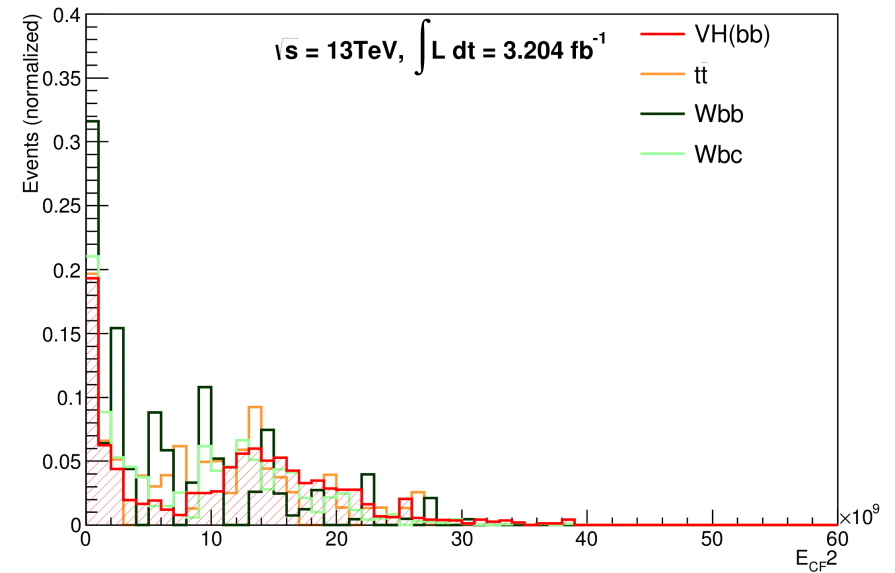
ECF1 substructure variable

ECF1	WH	Bkg.	Signific.
all	2.2973	14.3973	0.5903
> 200	2.2639	12.7933	0.6155
> 220	2.1135	8.2277	0.7082
> 240	1.7082	6.3817	0.6490
> 260	1.5082	5.4590	0.6188
> 300	0.7438	3.1167	0.4060



ECF2 substructure variable

ECF2	WH	Bkg.	Signific.
all	2.29732	14.3973	0.5903
> 2	1.8325	9.5891	0.5743
> 4	1.7703	6.5879	0.6619
> 6	1.7021	6.2633	0.6524
> 10	1.5233	5.2388	0.6367
< 20	1.9896	12.7280	0.5440
< 22	2.0750	13.1827	0.5574
< 24	2.1749	14.0836	0.5655



Summary and next steps

Summary:

- cuts on substructure variables can be used to reduce the background
- already analyzed: D2, ECF1, ECF2, ECF3, Tau1, Tau2, Tau3
 - best results for D2 (improves significance from 0.59 to 0.66) , ECF1 (0.71), ECF2 (0.66)
 - cuts on the other variables did not improve the significance

Next steps:

- make ROC curves in order to find out which further substructure variables to analyze
- improve binning, range of some plots